Electrogenic sulfur oxidation drives trace metal cycling in sediments from the Belgian Coastal Zone

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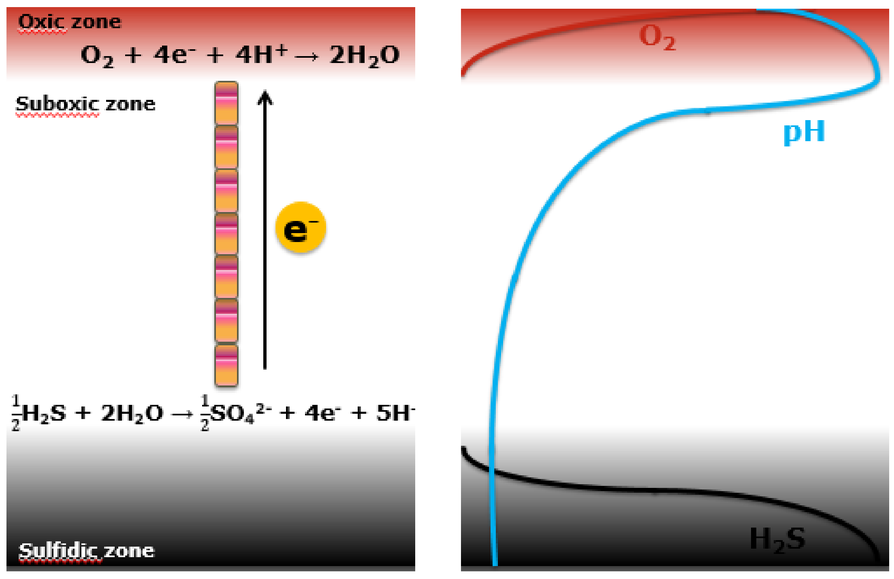
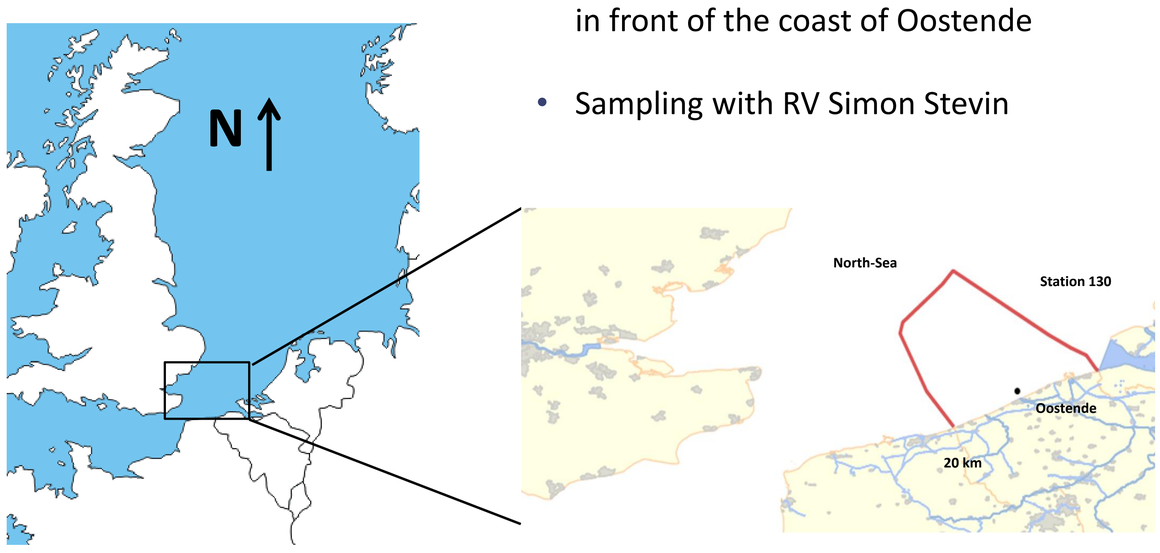
Introduction

- Electrogenic sulfur oxidation (e-SOx) is a newly discovered mechanism where sulfide oxidation and oxygen reduction are coupled via electrical currents mediated by cable bacteria over centimeter-scale distances [1]
- e-SOx generates a unique geochemical fingerprint in the pore water, which consists of a suboxic zone of several millimeters thickness, a distinct pH peak formed below the sediment water interface and an acidic pH minimum at the same depth as the sulfide appearance depth [2]
- The low pH associated with the sulfide oxidation dissolves iron sulfides and calcium carbonates, thereby strongly affecting the iron and calcium cycle
- The geochemical cycles of As and Co are strongly coupled to the cycle of Fe, hence our hypotheses are (i) e-SOx has a strong influence on the As and Co cycle and (ii) the presence of e-SOx leads to an increase in benthic flux for both As and Co

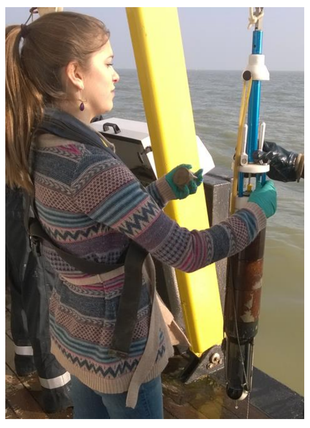


Material and Methods

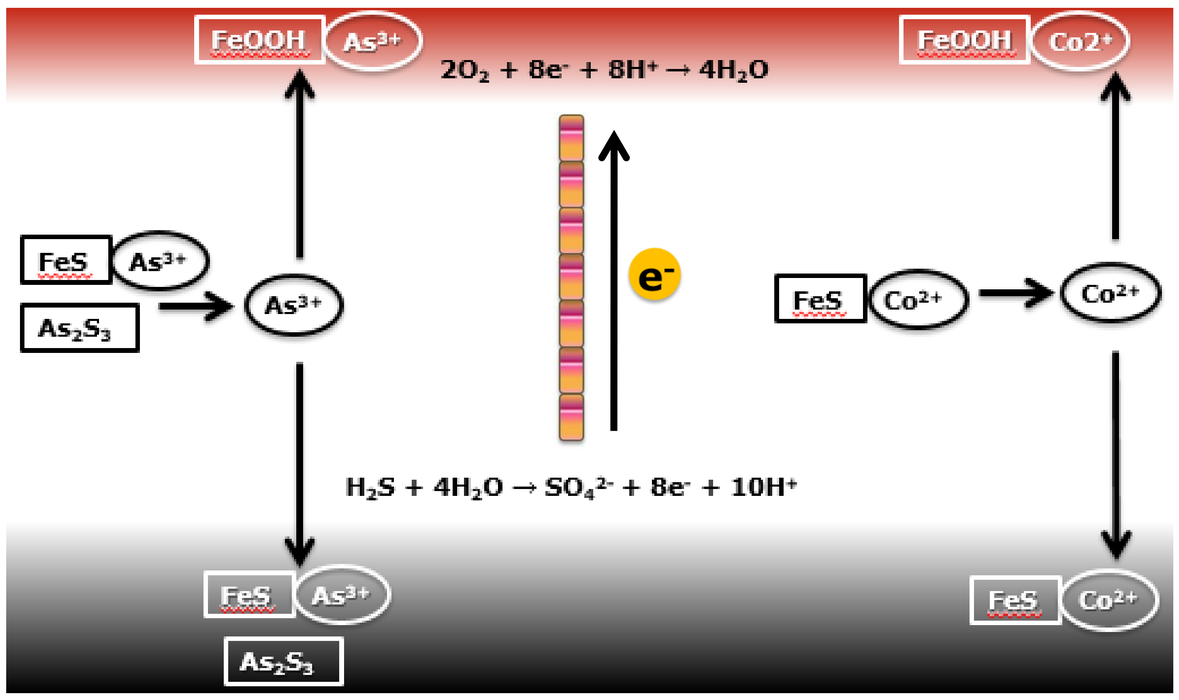
- Sediments were sampled in station 130 in the Belgian coastal zone located 5 km in front of the coast of Oostende
- Sampling with RV Simon Stevin



- Field samples and sediment incubation experiments
- Microsensor profiling – O_2, H_2S and pH
- Porewater analysis
- Solid phase analysis
  - (i) Trace metal speciation
  - (ii) Inorganic sulfur speciation

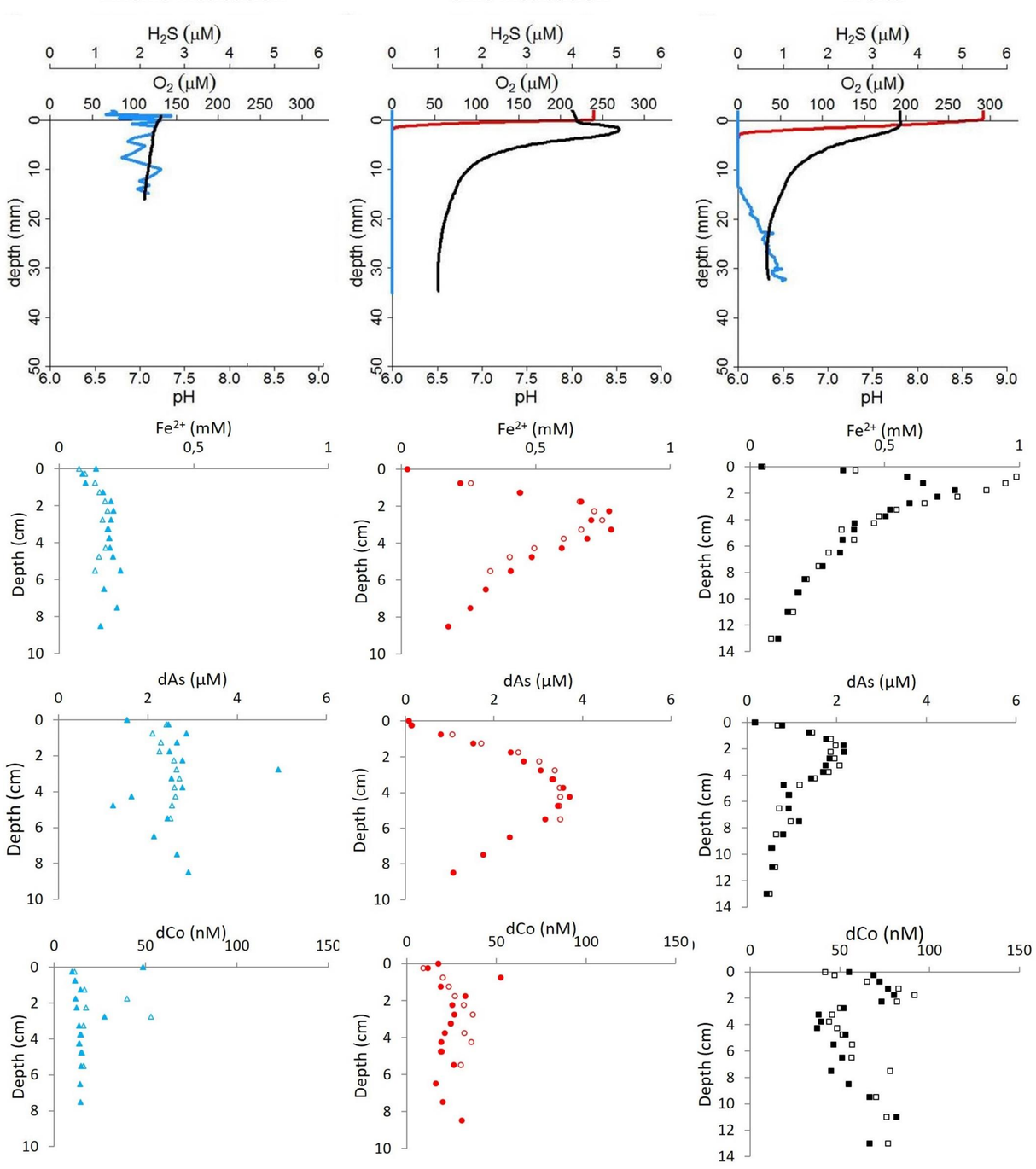


Conclusion



- Electrogenic sulfur oxidation has a large impact on trace metal remobilization in coastal sediments via the dissolution of sulfide minerals
- Estimated benthic fluxes of As and Co are 6-7 times higher in presence of e-SOx than previously observed

Results



- Microsensor profiling
  - (i) Signature pH profile of e-SOx is present in the field and oxic experimental incubation
  - (ii) No pH profile was observed during anoxic incubation
- Pore water analysis
  - (i) Net production in the upper zone for Fe^{2+}, dAs and dCo
  - (ii) Net consumption in the deeper zone for Fe^{2+}, dAs and dCo
  - (ii) Flux out of the sediment for Fe^{2+}, dAs and dCo
  - (iv) Straight profiles in the anoxic incubations indicate that the remobilization in the oxic and in situ cores where due to e-SOx

References

[1] Nielsen L.P., Risgaard-Petersen N., Fossing H., Christensen P.B. and Sayama M. (2010) Electric currents couple spatially separated biogeochemical processes in marine sediment. *Nature,* **463**, 1071–1074

[2] Meysman F. J. R., Risgaard-Petersen N., Malkin S. Y. and Nielsen L. P. (2015) The geochemical fingerprint of microbial long-distance transport in the sea floor. *Geochimica et Cosmochimica Acta*, **152**, 122-142